

Late Ordovician Articulate Brachiopods from Gunningbland, Central Western New South Wales

IAN G. PERCIVAL

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Ian G. Percival, Department of Geology and Geophysics, University of Sydney, Sydney, Australia 2006; manuscript received 18 April 1978, revised manuscript accepted 23 August 1978.

INTRODUCTION

Within the lower part of the late Eastonian — early Bolindian (late Caradoc equivalent) Goonumbla Volcanics at Gunningbland, 32 km west of Parkes, a unit of massive tuffaceous sandstone occurs which yields an abundant well-preserved fauna dominated by brachiopods and trilobites. This sandstone unit immediately overlies limestone containing corals and stromatoporoids indicative of a Fauna III age in the local biostratigraphic scheme established by Webby (1969). Further stratigraphic and locality data are given in Percival (1978).

Inarticulate brachiopods, and the most abundant plectambonitacean strophomenoid brachiopods from this locality have previously been described (Percival, 1978, 1979). Presented below are descriptions of other important elements of the brachiopod fauna.

SIGNIFICANCE OF THE FAUNA

Late Ordovician brachiopod faunas of central western New South Wales are characterized by a high degree of endemism especially at specific (and to a lesser extent, generic) level, as evidenced by the large proportion of new taxa described herein and previously (Percival, 1978, 1979). The biogeographically-significant non-endemic elements of these faunas, in particular those from the Gunningbland area, are divisible into two groups: one including cosmopolitan genera such as *Sowerbyella* and *Paterula*, and the other comprising forms showing pronounced affinities with genera previously recorded only from Kazakhstan. This latter assemblage includes *Kassinella*, *Dulankarella?* (Percival, 1979), and aff. *Leptellina* herein. Species of these genera closely comparable with those occurring at Gunningbland are recorded in Kazakhstan from the late Caradoc Anderken and Dulankara horizons, correlated with the Zones of *Dicranograptus clingani* and *Pleurograptus linearis* (Nikitin, 1972), and thus broadly contemporaneous with the stratigraphic position of the Gunningbland fauna. In addition, an undescribed species referred to '*Chonetoidea simorini* M. Borisyak in coll.' by Sokolskaya (1960, pl.27, figs. 24-25) is possibly congeneric with

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Durranelia Percival, 1979, described from Gunningbland and elsewhere in central western N.S.W.; the age of '*C. simorini*' is, however, not given more precisely than mid-Ordovician. The restricted occurrence of the cited brachiopod genera in Kazakhstan and New South Wales confirms the strong zoogeographic relationship between these areas in the middle and late Ordovician, recognized by Webby (1974) from studies of the trilobite distribution.

SYSTEMATIC DESCRIPTIONS

Morphological terminology used herein follows that of the *Treatise on Invertebrate Paleontology, Part H, Brachiopoda* (Williams and Rowell, 1965), with modifications employed by Percival (1979). Classification follows Pope (1976) for the superfamily Strophomenacea and Havlíček (1977) for Orthida. Specimens prefixed SUP are catalogued in the Palaeontological Collections of the Department of Geology and Geophysics, University of Sydney.

Abbreviations appearing in tables of measurements are as follows:

L, W, length, width of valve;

T, thickness of single valve;

Lmf, Wmf, maximum dimensions of muscle field from beak and midline respectively;

similarly for platform (Lp1, Wp1), socket ridges (Lsr, Wsr), brachiophore bases (Lbb, Wbb) and dental plates (Ldp, Wdp). Lengths and widths for last two parameters measured on internal moulds.

Ls, maximum extension of median ridge or septum from beak in designated valve;

N, OR, \bar{x} , s, number of specimens, observed range, mean, standard deviation from mean.

Order	ORTHIDA	Schuchert and Cooper, 1932
Suborder	ORTHIDINA	Schuchert and Cooper, 1932
Superfamily	PLECTORTHACEA	Schuchert, 1929
Family	PLECTORTHIDAE	Schuchert, 1929
Subfamily	PLECTORTHINAE	Schuchert, 1929
Genus	<i>DOLEROIDES</i>	Cooper, 1930

Type species: *Orthis gibbosa* Billings, 1857; original designation of Cooper, 1930, p. 375.

Doleroides sp.

Fig. 1, 13-16

Material: Five specimens (SUP 62555 a/b, 62556 - 62559) from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near 'Currajong Park' homestead, just north of Gunningbland (locality L51 of Percival, 1978).

Description: *Exterior of valves*. Subequally biconvex, brachial valve slightly deeper; broad dorsal fold and corresponding ventral sulcus developing anteriorly, anterior commissure noticeably uniplicate. Evenly broadly convex in posterior transverse profile; maximum height of pedicle valve about one-fifth valve length; brachial valve between one-fifth and three-eighths as high as long. Outline transversely sub-square; length averaging three-quarters valve width; maximum width at or slightly posterior to midlength. Beaks slightly projecting; hingelines of both valves five-eighths to two-thirds as wide as maximum width; cardinal extremities obtusely rounded, lateral and anterolateral margins broadly convex, anterior margin tending to be truncated. Ornament costellate with rounded ribs increasing by bifurcation (rarely by

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intercalation); 8 to 10 ribs in 5 mm at anterior valve margin. Concentric ornament either absent, or inconspicuous, comprising widely-spaced growth lines.

Ventral interarea high, curved; strongly apsacline to catacline; with wide, open delthyrium. Dorsal interarea lower, orthocline; notothyrium without covering plates.

Pedicle valve interior. Teeth large and stout, with deep oblique fossettes, supported from dorsal margin of hingeline by secondary callus replacing discrete dental plates. Muscle field elongately subcordate, extending to approximately one-third length, and one-quarter width, of valve, and enclosed laterally by low slightly convergent ridges; small linear adductor scars bisected by faint median ridge and contained anteriorly by low swelling at front of muscle field; diductors do not enclose adductors. Mantle canal impressions not observed, save for long divergent *vascula media*.

Brachial valve interior. Cardinal process linear, differentiated into thick smooth shaft and narrower short crenulated myophore, flanked by deep notothyrial cavities (Fig. 1, 14). Brachiophores long, rod-like, moderately divergent, supported for about half their length by bases converging anterior to shaft of cardinal process; prominent fulcral plates (Fig. 1, 14) bound large deep sockets anterolaterally. Median septum variable in development but generally indistinct beyond midlength of valve. Impressions of muscle scars and mantle canals obscure.

Measurements		L	W	L/W	T	Lmf	Wmf	Lsr	Wsr
SUP 62555 a/b	(Pedicle valve)	15.9	22.0	0.72	3.1	5.4	5.2	—	—
SUP 62556	(Brachial valve)	11.5	15.5	0.74	2.3	—	—	—	—
SUP 62557	(Brachial valve)	10.0	15.0	0.67	—	—	—	1.1	3.7
SUP 62558	(Brachial valve)	13.8	16.0	0.86	3.9	—	—	—	—
SUP 62559	(Brachial valve)	12.1	15.4	0.79	2.7	—	—	2.4	4.4

Remarks: Although insufficient material is available to warrant the establishment of a new species, or for adequate comparison with previously-described species, this form differs from most *Dolerooides* in having longer, less widely-flaring brachiophores.

Subfamily ORTHOSTROPHIINAE Schuchert and Cooper, 1931

Genus *SCAPHORTHIS* Cooper, 1956

Type species: *Scaphorthis virginiensis* Cooper, 1956, p.502 (original designation).

Scaphorthis? aulacis sp. nov.

Fig. 1, 1-11; Table 1

Etymology: *aulacis* (Latin) = furrow, in reference to the prominent dorsal sulcus.

Diagnosis: Subquadrate *Scaphorthis?* with high ventral fold and well-defined dorsal sulcus; convergent plates supporting brachiophores rudimentary to absent; median dorsal ridge lacking.

Material: Holotype (SUP 62549) and eleven paratypes (SUP 62543 - 62548, 62550 - 62554 a/b) from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near "Currajong Park" homestead, just north of Gunningbland; one paratype (SUP 62574) from underlying siltstone (locality L49 of Percival, 1978) also near "Currajong Park" homestead.

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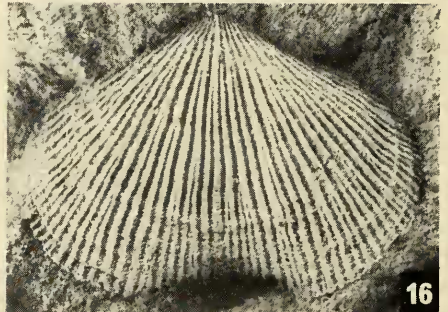
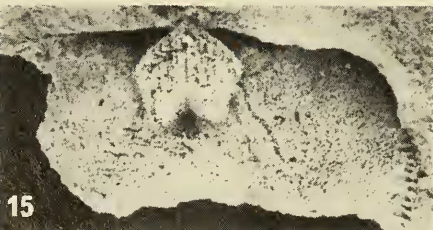
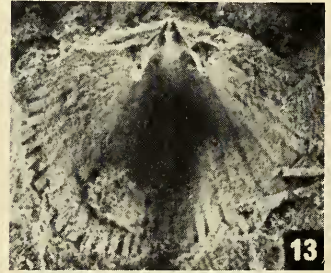
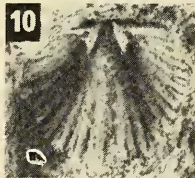
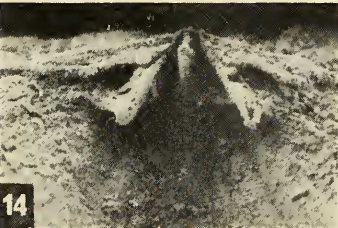
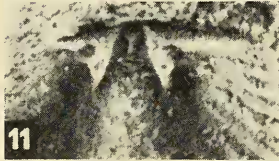
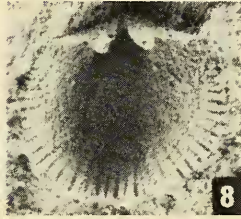
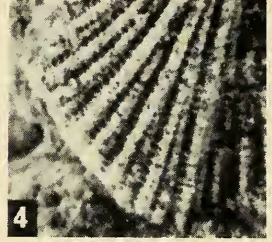
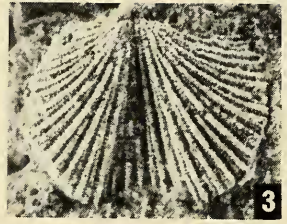
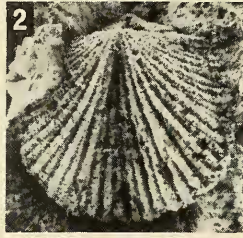
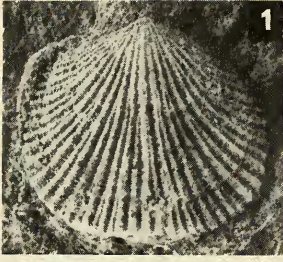
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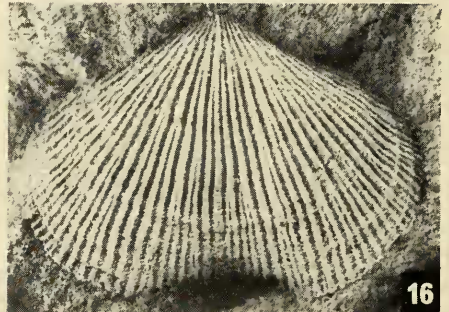
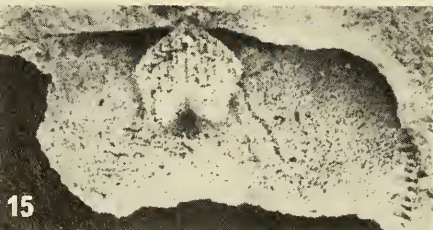
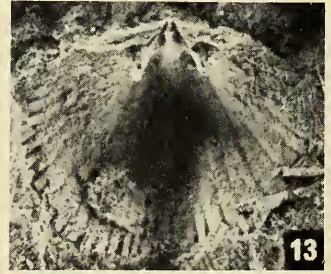
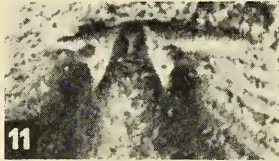
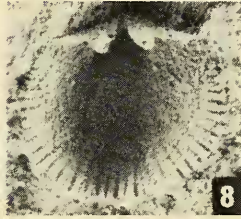
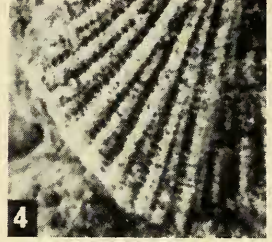
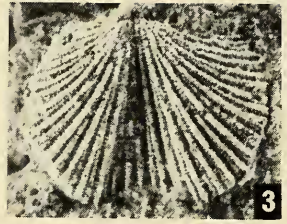
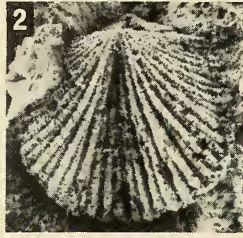
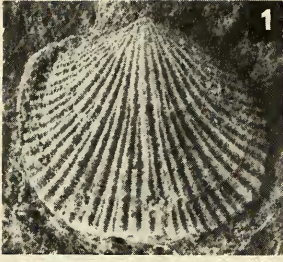
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four-fifths of respective valve widths; hingeline slightly less than maximum width which occurs at approximately midlength. Beaks weakly projecting; cardinal extremities obtusely rounded, lateral and anterior margins broadly convex. Anterior commissure weakly sulcate. Ornamentation costellate, costellae curved away from median line, increasing by bifurcation with 4 to 5 ribs per 1 mm at anterolateral margins of specimens 5 mm in length; ventral median rib may be slightly accentuated. Ribs cancellated by very fine closely spaced concentric filae (Fig. 1, 3, 4), approximately 9 to 11 per 1 mm of radius of valve, imparting reticulate appearance to shell surface. Shell substance fibrous.

Ventral interarea moderately high, planar, apsacline; delthyrium narrowly triangular, open, but with very short transversely striated pedicle collar apically (Fig. 1, 7, 8). Dorsal interarea low, anacline, approximately same width as that of pedicle valve; notothyrium open.

Pedicle valve interior. Teeth small, simple, with oblique fossettes; supported by divergent receding dental plates extending to about one-sixth valve length; umbonal chambers small but deep. Muscle field short, subcordate, restricted to vicinity of delthyrial cavity, and occupying one-third valve width; adductor and diductor impressions not distinct. Mantle canal impressions obscure except for long *vascula media* divergent from anterior extremity of muscle field. Periphery of valve bears plicate impressions of external ribbing.

Brachial valve interior. Cardinal process a thin simple ridge not extending anteriorly beyond notothyrial chamber; notothyrial platform not thickened; median septum not developed. Brachiophores are moderately long stout blades (Fig. 1, 10, 11) supported by divergent bases on valve floor for most or all of their length; brachiophore bases extend to approximately one-fifth valve length and are about one-quarter valve width apart at their distal extremities. Minute anterior extensions of bases in holotype (Fig. 1, 10, 11) faintly convergent (observed in this specimen only). Small deeply conical sockets excavated between brachiophores and hingeline; fulcral plates rudimentary or absent. Muscle scars and mantle canal impressions not observed. Measurements are given in Table 1.

Remarks: In external and internal morphology the new species described above closely resembles some of the early dalmanellidines. Such similarity is apparently superficial, as a fragment of shell adherent to a ventral internal mould (SUP 62574) attributed to this species proved to be impunctate when sectioned. Comparable examples of homeomorphy are known from other orthidine groups. Havlíček (1977) noted two families of orthaceans (Ranorthidae; Nanorthidae) of early Ordovician age which also are of dalmanellid appearance, yet are impunctate. Several plectorthacean genera (family Plectorthidae) are also superficially similar in

Fig. 1. Specimens from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, Gunningbland, New South Wales.

1-11. *Scaphorthis? aulacis* sp. nov. All x5 except 4, 11 both x10. 1. Latex impression from pedicle valve external mould, paratype SUP 62547. 2. Latex impression from brachial valve external mould, paratype SUP 62545/b. Interarea of attached pedicle valve visible. 3-4. Latex impression from brachial valve external mould, paratype SUP 62550, showing ornament in detail. 5-6. Pedicle valve internal mould, and latex impression from same, paratype SUP 62548. Interarea above tooth on left side of 6 damaged by air bubble in latex. 7-8. Pedicle valve internal mould, and latex impression from same, paratype SUP 62546. 9-11. Brachial valve internal mould, latex impression from same, and enlargement of cardinalia, holotype SUP 62549. Note attitude of brachiophores and their supporting bases.

12. *Oepikina?* sp. x1.3. Latex impression from brachial valve internal mould, SUP 62568.

13-16. *Doleroides* sp., 13, 15-16 x2.5; 14 x5. 13-14. Latex impression from brachial valve internal mould, and enlargement of cardinalia of same (slightly tilted), SUP 62559. 15-16. Pedicle valve internal mould, and latex impression from pedicle valve external mould, SUP 62555 a/b.

four-fifths of respective valve widths; hingeline slightly less than maximum width which occurs at approximately midlength. Beaks weakly projecting; cardinal extremities obtusely rounded, lateral and anterior margins broadly convex. Anterior commissure weakly sulcate. Ornamentation costellate, costellae curved away from median line, increasing by bifurcation with 4 to 5 ribs per 1 mm at anterolateral margins of specimens 5 mm in length; ventral median rib may be slightly accentuated. Ribs cancellated by very fine closely spaced concentric filae (Fig. 1, 3, 4), approximately 9 to 11 per 1 mm of radius of valve, imparting reticulate appearance to shell surface. Shell substance fibrous.

Ventral interarea moderately high, planar, apsacline; delthyrium narrowly triangular, open, but with very short transversely striated pedicle collar apically (Fig. 1, 7, 8). Dorsal interarea low, anacline, approximately same width as that of pedicle valve; notothyrium open.

Pedicle valve interior. Teeth small, simple, with oblique fossettes; supported by divergent receding dental plates extending to about one-sixth valve length; umbonal chambers small but deep. Muscle field short, subcordate, restricted to vicinity of delthyrial cavity, and occupying one-third valve width; adductor and diductor impressions not distinct. Mantle canal impressions obscure except for long *vascula media* divergent from anterior extremity of muscle field. Periphery of valve bears plicate impressions of external ribbing.

Brachial valve interior. Cardinal process a thin simple ridge not extending anteriorly beyond notothyrial chamber; notothyrial platform not thickened; median septum not developed. Brachiophores are moderately long stout blades (Fig. 1, 10, 11) supported by divergent bases on valve floor for most or all of their length; brachiophore bases extend to approximately one-fifth valve length and are about one-quarter valve width apart at their distal extremities. Minute anterior extensions of bases in holotype (Fig. 1, 10, 11) faintly convergent (observed in this specimen only). Small deeply conical sockets excavated between brachiophores and hingeline; fulcral plates rudimentary or absent. Muscle scars and mantle canal impressions not observed. Measurements are given in Table 1.

Remarks: In external and internal morphology the new species described above closely resembles some of the early dalmanellidines. Such similarity is apparently superficial, as a fragment of shell adherent to a ventral internal mould (SUP 62574) attributed to this species proved to be impunctate when sectioned. Comparable examples of homeomorphy are known from other orthidine groups. Havlíček (1977) noted two families of orthaceans (Ranorthidae; Nanorthidae) of early Ordovician age which also are of dalmanellid appearance, yet are impunctate. Several plectorthacean genera (family Plectorthidae) are also superficially similar in

Fig. 1. Specimens from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, Gunningbland, New South Wales.

1-11. *Scaphorthis? aulacis* sp. nov. All x5 except 4, 11 both x10. 1. Latex impression from pedicle valve external mould, paratype SUP 62547. 2. Latex impression from brachial valve external mould, paratype SUP 62545/b. Interarea of attached pedicle valve visible. 3-4. Latex impression from brachial valve external mould, paratype SUP 62550, showing ornament in detail. 5-6. Pedicle valve internal mould, and latex impression from same, paratype SUP 62548. Interarea above tooth on left side of 6 damaged by air bubble in latex. 7-8. Pedicle valve internal mould, and latex impression from same, paratype SUP 62546. 9-11. Brachial valve internal mould, latex impression from same, and enlargement of cardinalia, holotype SUP 62549. Note attitude of brachiophores and their supporting bases.

12. *Oepikina?* sp. x1.3. Latex impression from brachial valve internal mould, SUP 62568.

13-16. *Doleroides* sp., 13, 15-16 x2.5; 14 x5. 13-14. Latex impression from brachial valve internal mould, and enlargement of cardinalia of same (slightly tilted), SUP 62559. 15-16. Pedicle valve internal mould, and latex impression from pedicle valve external mould, SUP 62555 a/b.

TABLE 1
Measurements of *Scaphorthis? aulacis* sp. nov.

	L	W	L/W	Ldp	Wdp	$\frac{Ldp}{L}$	$\frac{Wdp}{W}$	Lbb	Wbb	$\frac{Lbb}{L}$	$\frac{Wbb}{W}$
Holotype SUP 62549 (Brachial valve)	3.5	4.6	0.76	—	—	—	—	0.8	1.0	0.23	0.22
Paratype SUP 62548 (Pedicel valve)	5.5	6.2	0.89	0.8	2.0	0.15	0.32	—	—	—	—
Pedicel valves	N	9	9	9	4	4	4	4			
	OR	3.4–	4.0–	0.75–	0.5–	1.5–	0.15–	0.25–	—	—	—
	\bar{x}	6.8	7.8	0.96	0.9	2.0	0.18	0.38			
	s	5.2	6.0	0.88	0.8	1.8	0.16	0.32			
	s	1.0	1.1	0.06	0.2	0.2	0.01	0.05			
Brachial valves	N	11	11	11				5	5	5	5
	OR	3.5–	4.3–	0.71–	—	—	—	0.7–	1.0–	0.15–	0.21–
	\bar{x}	5.8	7.0	0.94	—	—	—	1.0	1.4	0.26	0.30
	s	4.3	5.3	0.81				0.8	1.2	0.20	0.25
	s	0.8	0.9	0.07				0.1	0.2	0.04	0.04

appearance to dalmanellidines. Of these, *Scaphorthis* Cooper (in particular *S. sulcata* Wright) is most like the form described above. Wright (1964, p.202) in establishing *S. sulcata* commented on the "dalmanelloid appearance of the shell and the style of cardinalia" of this species, and of *Corineorthis* Stubblefield, *Giraldiella* Bancroft, and *Scaphorthis* in general.

The new species does not conveniently fit into either the Orthacea or Plectorthacea. In the holotype (the best-preserved brachial valve) rudimentary concave plates converge beneath the anterior ends of the brachiophores (Fig. 1, 10, 11). This feature suggests affinities with the Plectorthacea, especially in view of other similarities (discussed below) with *Scaphorthis sulcata*. However, in most other examples of the new species, the anteriorly-divergent brachiophores are attached to the valve floor throughout the majority of their length. Thus the Gunningbland species could equally well be assigned to the Orthacea (Ranorthidae), and compared with *Eodalmanella* Havlíček (presently known only from one species of Llanvirn age from Czechoslovakia). Overall it would seem best tentatively to refer the new species to *Scaphorthis*, a more widespread genus of middle and late Ordovician age.

Like the Portrane Limestone species *S. sulcata* Wright, of Ashgill age, *S.? aulacis* displays a reticulate external appearance imparted by closely-set growth lines intersecting the fascicostellate radial ornament. As noted by Wright (1964, p.203) this feature distinguishes *S. sulcata* from American species of *Scaphorthis*. In addition (and again serving to differentiate them from the American species), both *S. sulcata* and *S.? aulacis* are characterized by the presence of a well-defined dorsal sulcus and the absence of a thickened internal median ridge in the brachial valve. A pedicle callist is present in both species. However, *S.? aulacis* is much less transverse in outline than *S. sulcata*, and more importantly lacks the distinct convergent plates supporting the brachiophores as developed in the latter. Differences are also noted in relative dimensions of cardinalia and ventral muscle fields of the two species. The ranorthid *Eodalmanella* Havlíček differs from *S.? aulacis* in lacking a pedicle callist and in displaying well-defined muscle scars and vascular impressions in the brachial valve. Another distinguishing feature is valve outline, *Eodalmanella* being widest at the hingeline whereas the maximum width of *S.? aulacis* coincides more or less with midlength.

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Pedicel valves	$\left\{ \begin{array}{l} N \\ OR \\ \bar{x} \\ s \end{array} \right.$	9	9	9	4	4	4	4				
		3.4–	4.0–	0.75–	0.5–	1.5–	0.15–	0.25–	—	—	—	—
		6.8	7.8	0.96	0.9	2.0	0.18	0.38				
		5.2	6.0	0.88	0.8	1.8	0.16	0.32				
		1.0	1.1	0.06	0.2	0.2	0.01	0.05				
Brachial valves	$\left\{ \begin{array}{l} N \\ OR \\ \bar{x} \\ s \end{array} \right.$	11	11	11					5	5	5	5
		3.5–	4.3–	0.71–					0.7–	1.0–	0.15–	0.21–
		5.8	7.0	0.94	—	—	—	—	1.0	1.4	0.26	0.30
		4.3	5.3	0.81					0.8	1.2	0.20	0.25
		0.8	0.9	0.07					0.1	0.2	0.04	0.04

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 Suborder STROPHOMENIDINA Öpik, 1934
 Superfamily PLECTAMBONITACEA Jones, 1928
 Family LEPTELLINIDAE Ulrich and Cooper, 1936
 Subfamily LEPTELLININAE Ulrich and Cooper, 1936

aff. *Leptellina* sp.

Fig. 2, 6-9

Material: Five specimens (SUP 61461, 62539-62542) from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near "Currajong Park" homestead, just north of Gunningbland.

Description: Valves plano- to concavo-convex; subquadrate to subrectangular; length five-eighths to seven-tenths valve width; maximum width at about midlength; cardinal extremities acutely angular, lateral margins sigmoidal, anterior margin broadly convex. Details of ornament unknown. Dorsal interarea anacline; orientation of ventral interarea unknown, pseudodeltidium small.

Pedicle valve interior. Teeth stout, pointed, with narrow oblique fossettes, supported by thickened wall of delthyrial cavity. Muscle field cordate, extending to almost midlength and occupying one-third valve width; bisected by thin median ridge; adductor scars not distinguished from diductors. Low arcuate bars of shell material anterolateral to muscle scars bear shallow impressions of mantle canals.

Brachial valve interior. Cardinal process trilobed, low and broad; socket ridges short, straight and widely divergent, with thickened distal extremities recurved posteriorly. Prominent elongately conical median septum rises abruptly at about one-third valve length from callus anterior to low notothyrial platform; sharply ventrally-peaked anterior end of septum at approximately seven-tenths valve length bears shallow tubular posteriorly-directed excavation; septum does not extend to platform rim. Platform wide and long, occupying eight to nine-tenths valve length and width, with high flared and slightly undercut rim in adults; rim barely indicated in juveniles. Elongate adductor scars deeply excavated on either side of septum in central portion of platform (Fig. 2, 6). Pair of *vascula media* canals lies along sides of median septum, extending beyond its termination through anteromedian gap in platform rim; two pairs of long straight canal impressions (*vascula myaria*) diverge anterolaterally, *vascula genitalia* indistinct.

<i>Measurements</i>		L	W	L/W	Lmf	Wmf	Lsr	Wsr	Ls	Lpl	Wpl
SUP 61461	(Pedicle valve)	4.4	7.0	0.63	1.9	2.4	—	—	—	—	—
SUP 62539	(Brachial valve)	4.1	5.8	0.71	1.1	1.7	0.7	2.3	2.9	3.2	4.9
SUP 62540	(Brachial valve)	4.0	6.1	0.66	1.1	2.3	0.9	2.6	2.7	3.4	5.1
SUP 62541	(Brachial valve)	3.8	5.8	0.66	—	—	0.7	2.3	2.7	3.2	4.5
SUP 62542	(Brachial valve)	4.2	6.2	0.68	—	—	0.9	2.7	3.0	3.8	5.1

Remarks: This distinctive form, characterized by a large ventral muscle field bisected by a thin median ridge, and thick dorsal median septum not extending to platform rim, is best left in open nomenclature until further material displaying the ornament is available. Close comparison is possible with only one other described species — *Leptelloidea multicostata* Rukavishnikova (1956, p.132) from the Anderken and Otarsk horizons (mid-late Caradoc) of Kazakhstan. This species was referred to variously by Nikitin (1972) as *Leptelloidea? multicostata*, *Leptellina multicostata*, and *Leptellina? multicostata*, in addition to the original designation of Rukavishnikova (1956). It belongs, however, to neither *Leptelloidea* nor *Leptellina*, differing from both in appearance of the dorsal median septum, especially termination of the latter posterior to the platform rim. The cardinalia of the Kazakh

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 Genus SOWERBYELLA Jones, 1928

Type species: *Leptaena sericea* Sowerby, 1839; original designation of Jones, 1928, p.384.

Diagnosis: See Williams, 1965, pp. H378-9.

Sowerbyella anticipata sp. nov.

Fig. 2, 1-5

Etymology: In reference to advanced features of this species, foreshadowing later denticulate sowerbyellids (Latin *anticipatus*: foretell).

Diagnosis: Large *Sowerbyella* with deeply inset ventral adductors; dorsal muscle field and septa not thickened; rudimentary accessory pair of ventral denticles and dorsal sockets present on hingeline.

Material: Holotype (SUP 62570) and three paratypes (SUP 62571-62573) from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near "Currajong Park" homestead, just north of Gunningbland.

Description: *Exterior of valves*. Moderately concavo-convex shell, depth approximately one-fifth valve length; outline transverse, maximum width at hingeline; valve length between half and three-fifths width. Cardinal extremities subrectangular to acute, lateral and anterior margins broadly rounded. Brachial valve with broad shallow sulcus rapidly widening anteriorly; ornament unequally parvicostellate (available exterior inadequately preserved for measurements of rib distribution); indistinct short oblique rugae present adjacent to posterolateral hingeline. Pedicle valve ornament not seen; interarea apsacline; delthyrium wide, pseudodeltidium small, apical. Dorsal interarea anacline to catacline; notothyrium covered by small chilidial plates. Shell substance pseudopunctate.

Pedicle valve interior. Oblique ridge-like teeth project laterally from wall of delthyrial cavity. Additional low tubercle present on hingeline on each side of beak about one-third distance toward cardinal extremities (Fig. 2, 5) presumably also assisted in articulation, being accommodated in shallow linear socket (buttressed anteriorly by short ridge) on brachial valve hingeline (Fig. 2, 1). Muscle field bilobed; adductor scars small, elliptical, with posterior ends deeply inserted beneath small pedicle callist in delthyrial cavity. Adductors separated by short median septum which forks at 70°-80°, between one-fifth and one-quarter valve length from beak, into low ridges outlining rectangular diductor scars; latter extend to between half and five-eighths valve length, and occupy one-third to two-fifths valve width. Mantle canal pattern lemniscate.

Brachial valve interior. Ridge-like cardinal process laterally fused to chilidial plates, forming arcuate shelf over deeply excavated alveolus; socket ridges very short, straight, widely divergent. Median septum weak, commencing at three-tenths valve length and extending to seven-tenths length, flanked by stronger moderately divergent submedian septa commencing beneath cardinalia; submedian septa not thickened anteriorly. Muscle field indistinct, lacking thickened floor and lateral bounding

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ridges, crossed by divergent weakly-developed transmuscle septa. Mantle canal pattern not preserved.

Measurements		L	W	L/W	T	Lmf	Wmf	Ls	Lsr	Wsr
SUP 62570	(Pedicel valve)	12.9	21.9	0.59	2.4	6.4	7.8	3.0	—	—
SUP 62571	(Pedicel valve)	13.0	22.0	0.59	2.5	5.6	8.7	2.8	—	—
SUP 62572	(Brachial valve)	12.3	22.8	0.54	—	—	—	—	—	—
SUP 62573	(Brachial valve)	8.7+	15.3	—	—	—	—	—	1.6	3.9

Remarks. The large size and deeply inserted ventral adductor muscles imply that this is an advanced species of *Sowerbyella*; broadly similar North American forms are of Trenton and Eden age (Howe, 1972). Of considerable significance is the rudimentary accessory hingeline denticulation which, according to Howe (1972, p.443), is a feature of *Eoplectodonta* or *Thaerodonta* rather than *Sowerbyella*. The species described here, which in all other details conforms to *Sowerbyella*, possibly represents a transitional form approaching *Eoplectodonta*.

Sowerbyella anticipata is distinguished from all known *Sowerbyella* sensu stricto by absence of thickening of the dorsal muscle field and septa, and development of rudimentary accessory denticulation. There is little similarity between this species and *S. lepta* occurring in slightly older strata at "New Durran" south-east of Gunningbland (Percival, 1979). The two differ most noticeably in size, profile, dimensions and appearance of muscle fields in both valves, and in details of cardinalia.

Superfamily STROPHOMENACEA King, 1846

Family OEPIKINIDAE Sokolskaya, 1960

Oepikina? sp.

Fig. 1, 12

Material: One brachial valve internal mould, SUP 62568, from tuffaceous sandstone unit in lower part of Goonumbra Volcanics, near "Currajong Park" homestead, just north of Gunningbland.

Description: *Brachial valve* subquadrate, widest at hingeline; length three-quarters width; planar to weakly convex with narrow dorsally-geniculate anterolateral and anterior margins. Interarea anacline. Cardinal process bilobed above alveolus excavated posteriorly in low notothyrial platform; socket ridges short, straight, very widely divergent, sharply recurved toward hingeline distally. Short median septum extends anteriorly from notothyrial platform, dividing at one-quarter valve length into three indistinct subparallel septa terminating at about midlength, and flanked by stronger bladlike pair of subparallel submedian septa. Muscle scars suboval, extending to three-eighths valve length and width; transmuscle septa lacking. Mantle canals indistinct but pattern apparently saccate. Conspicuous subperipheral rim present. *Pedicel valve* unknown.

Measurements: Length 25.3 mm, width 33.5 mm.

Remarks: The specimen differs from other species of *Oepikina* in form and arrangement of its septa, development of a circular alveolus (rather than a longitudinal groove) beneath the cardinal process lobes, and in the extended recurved distal portions of the socket ridges. Although it exhibits the characteristic subperipheral rim of *Oepikina*, generic determination remains uncertain until the pedicle valve is known.

A single brachial valve external mould (SUP 62569) of weakly concave profile and subquadrate outline possibly belongs to the same species as that described above. Although this specimen, measuring 13.5 mm in length and 17.5 mm width, is only about half the size of SUP 62568, the two have almost identical length: width ratios. The external mould indicates that the ornament comprised fine multicostellae crossed

ridges, crossed by divergent weakly-developed transmuscle septa. Mantle canal pattern not preserved.

Measurements		L	W	L/W	T	Lmf	Wmf	Ls	Lsr	Wsr
SUP 62570	(Pedicel valve)	12.9	21.9	0.59	2.4	6.4	7.8	3.0	—	—
SUP 62571	(Pedicel valve)	13.0	22.0	0.59	2.5	5.6	8.7	2.8	—	—
SUP 62572	(Brachial valve)	12.3	22.8	0.54	—	—	—	—	—	—
SUP 62573	(Brachial valve)	8.7+	15.3	—	—	—	—	—	1.6	3.9

Remarks. The large size and deeply inserted ventral adductor muscles imply that this is an advanced species of *Sowerbyella*; broadly similar North American forms are of Trenton and Eden age (Howe, 1972). Of considerable significance is the rudimentary accessory hingeline denticulation which, according to Howe (1972, p.443), is a feature of *Eoplectodonta* or *Thaerodonta* rather than *Sowerbyella*. The species described here, which in all other details conforms to *Sowerbyella*, possibly represents a transitional form approaching *Eoplectodonta*.

Sowerbyella anticipata is distinguished from all known *Sowerbyella* sensu stricto by absence of thickening of the dorsal muscle field and septa, and development of rudimentary accessory denticulation. There is little similarity between this species and *S. lepta* occurring in slightly older strata at "New Durran" south-east of Gunningbland (Percival, 1979). The two differ most noticeably in size, profile, dimensions and appearance of muscle fields in both valves, and in details of cardinalia.

Superfamily STROPHOMENACEA King, 1846

Family OEPIKINIDAE Sokolskaya, 1960

Oepikina? sp.

Fig. 1, 12

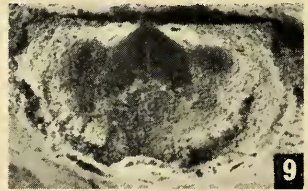
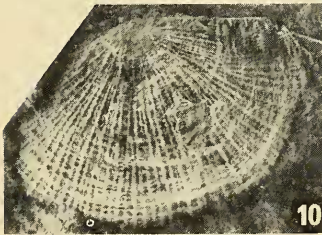
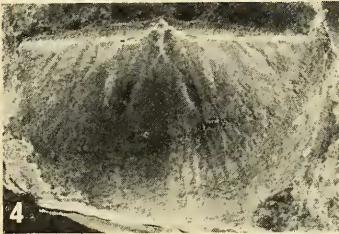
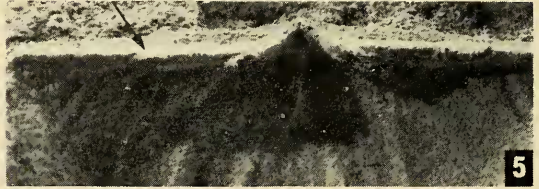
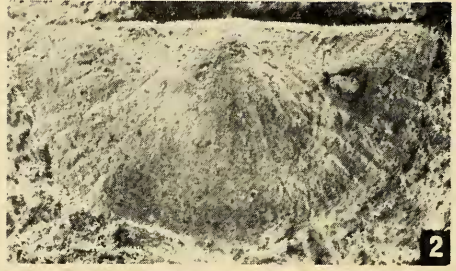
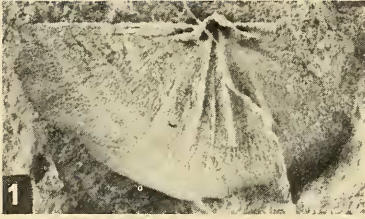
Material: One brachial valve internal mould, SUP 62568, from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near "Currajong Park" homestead, just north of Gunningbland.

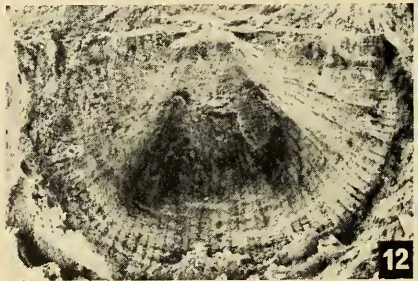
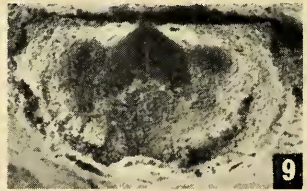
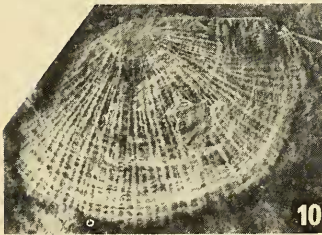
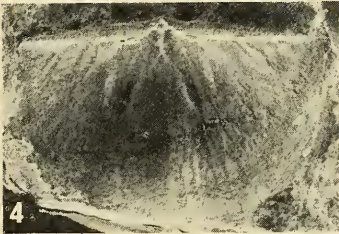
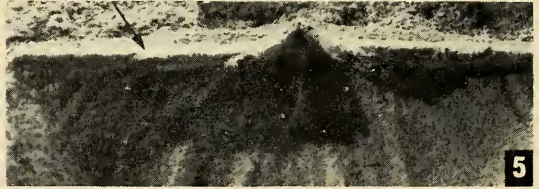
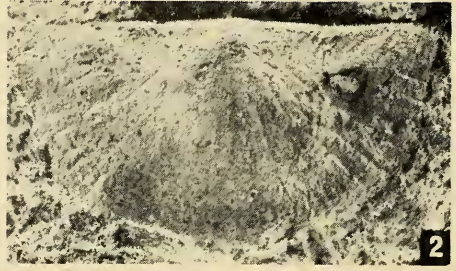
Description: *Brachial valve* subquadrate, widest at hingeline; length three-quarters width; planar to weakly convex with narrow dorsally-geniculate anterolateral and anterior margins. Interarea anacline. Cardinal process bilobed above alveolus excavated posteriorly in low notothyrial platform; socket ridges short, straight, very widely divergent, sharply recurved toward hingeline distally. Short median septum extends anteriorly from notothyrial platform, dividing at one-quarter valve length into three indistinct subparallel septa terminating at about midlength, and flanked by stronger bladlike pair of subparallel submedian septa. Muscle scars suboval, extending to three-eighths valve length and width; transmuscle septa lacking. Mantle canals indistinct but pattern apparently saccate. Conspicuous subperipheral rim present. *Pedicel valve* unknown.

Measurements: Length 25.3 mm, width 33.5 mm.

Remarks: The specimen differs from other species of *Oepikina* in form and arrangement of its septa, development of a circular alveolus (rather than a longitudinal groove) beneath the cardinal process lobes, and in the extended recurved distal portions of the socket ridges. Although it exhibits the characteristic subperipheral rim of *Oepikina*, generic determination remains uncertain until the pedicle valve is known.

A single brachial valve external mould (SUP 62569) of weakly concave profile and subquadrate outline possibly belongs to the same species as that described above. Although this specimen, measuring 13.5 mm in length and 17.5 mm width, is only about half the size of SUP 62568, the two have almost identical length: width ratios. The external mould indicates that the ornament comprised fine multicostellae crossed





by delicate crowded concentric filae, with three to four costellae per mm at the anterior margin; this ornament resembles that of the type species of *Oepikina*, *O. septata* Salmon (Cooper, 1956, pl. 239B, fig. 21).

Family STROPHOMENIDAE King, 1846
 Subfamily FURCITELLINAE Williams, 1965
 Genus *INFURCA* gen. nov.

Type species : *Infurca tessellata* gen. et sp. nov.

Etymology: Alluding to undivided dorsal median septum, *in-* without, *furca* fork (Latin).

Diagnosis: Convexo-planar to dorsibiconvex furcitellin with conspicuous concentric lamellae intersecting multicostellate ornament; pseudodeltidium small, foramen apparently absent; teeth denticulate, supported by weakly divergent plates laterally bounding pentagonal muscle field; dorsal median septum undivided, other dorsal septa inconspicuous or lacking.

Discussion: Multicostellate ornament, valve profile, and form of ventral muscle field are consistent with the assignment of the new genus to the Furcitellinae, although it differs from other genera of that subfamily in having only a small pseudodeltidium, and in apparently lacking a pedicle foramen. However, available external moulds were not entirely suitable for preservation of the internal infilling of such a structure if it existed, and subsequent material may reveal the presence of a small apical foramen. Reduction in number and degree of development of dorsal septa is also a distinguishing feature of *Infurca*, recalling the early furcitellin *Trotlandella* Neuman, 1974, from Llanvirn age strata near Trondheim, Norway. Other features common to *Infurca* and *Trotlandella* include small ventral muscle field restricted to delthyrial cavity, and multicostellate ornament intersected by conspicuous concentric rugae-like growth lamellae. *Infurca* is readily distinguished from *Trotlandella* in lacking the large pseudodeltidium of the latter, and in having divergent dental plates (rather than anteriorly convergent as in *Trotlandella*). Perhaps the most fundamental distinction between these genera concerns relative development of cardinalia; the cardinal process lobes of *Infurca* are considerably more prominent than those of *Trotlandella* which also is characterized by elevated sockets — a feature not present in *Infurca*. Other Ordovician furcitellins, such as *Furcitella* Cooper and *Holtedahlina* Foerste, differ from *Infurca* in having more robust cardinalia and strongly developed dorsal ridges with an anteriorly bifurcating median septum. Early Silurian species of *Katastrophomena* Cocks exhibit weak development of dorsal septa comparable to *Infurca* and display a similar ornament (termed *scoticoid* by Pope, 1976), but differ from the new genus in their resupinate profile.

Fig. 2. Specimens from tuffaceous sandstone unit in lower part of Goonumbra Volcanics, Gunningbland, New South Wales.

1-5. *Sowerbyella anticipata* sp. nov. 1. Latex impression from brachial valve internal mould, paratype SUP 62573, x3. 2. Latex impression from brachial valve external mould, paratype SUP 62572, x2.5. 3-5. Pedicle valve internal mould, latex impression from same, and enlargement of hingeline (slightly tilted), holotype SUP 62570. Arrow on 5 indicates position of accessory hingeline denticulation. 3, 4 x2; 5 x4.

6-9 aff. *Leptellina* sp., all x5. 6, 7. Latex impressions from brachial valve internal moulds, SUP 62540 and SUP 62542 respectively. 8. Latex impression from juvenile brachial valve internal mould, SUP 62541. 9. Latex impression from pedicle valve internal mould SUP 61461.

10-15. *Infurca tessellata* gen. et sp. nov. 10. Latex impression from brachial valve external mould, paratype SUP 62563, x2. 11. Latex impression from pedicle valve external mould, paratype SUP 62566, showing ornament, x3. 12. Latex impression from brachial valve internal mould, holotype SUP 62560, x2.5. 13. Latex impression from brachial valve internal mould, paratype SUP 62562, x2. 14-15. Latex impression from pedicle valve internal mould, and enlargement showing denticles on dental plates, and muscle field, SUP 62564, x2 and x5 respectively.

by delicate crowded concentric filae, with three to four costellae per mm at the anterior margin; this ornament resembles that of the type species of *Oepikina*, *O. septata* Salmon (Cooper, 1956, pl. 239B, fig. 21).

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10-15. *Infurca tessellata* gen. et sp. nov. 10. Latex impression from brachial valve external mould, paratype SUP 62563, x2. 11. Latex impression from pedicle valve external mould, paratype SUP 62566, showing ornament, x3. 12. Latex impression from brachial valve internal mould, holotype SUP 62560, x2.5. 13. Latex impression from brachial valve internal mould, paratype SUP 62562, x2. 14-15. Latex impression from pedicle valve internal mould, and enlargement showing denticles on dental plates, and muscle field, SUP 62564, x2 and x5 respectively.

Infurca tessellata gen. et sp. nov.

Fig. 2, 10-15

Etymology: Referring to chequered appearance of ornament; Latin *tessellatus* chequered.

Diagnosis: Characters of genus.

Material: Holotype (SUP 62560) and seven paratypes (SUP 62561 — 62567) from tuffaceous sandstone unit in lower part of Goonumbla Volcanics, near "Currajong Park" homestead, just north of Gunningbland.

Description: *Exterior of valves*. Convexo-planar to dorsibiconvex transversely subquadrate shells with obtusely-rounded cardinal extremities and broadly-rounded lateral and anterior margins; maximum width at about one-third valve length from beak, valve length three-fifths to seven-tenths width. Pedicle valve approximately one-tenth as deep as long, with subdued median fold of variable width, flanked laterally by triangular depressed areas; posterolateral corners of valve flattened or slightly oblique to plane of commissure, anterior and anterolateral margins frequently narrowly geniculate. Brachial valve has indistinct median sulcus in posterior half of valve; prominently convex medially; between one-sixth and one-quarter as deep as long, and (estimated) about twice depth of corresponding pedicle valve; posterolateral corners flattened. Both valves ornamented with coarse concentric rugae-like growth lamellae, imparting chequered appearance to exterior. Costellae and growth lamellae equally prominent or, more commonly, costellae slightly stronger in development bearing small nodes at junction with concentric lamellae. Superimposed on chequered ornament are more-widely-spaced step-like growth hiatuses. Ten to twelve costellae occupy 5 mm along front margin of valves. Pedicle valve interarea aplanate; delthyrium wide, pseudodeltidium small, apical, highly convex; foramen not apparent. Brachial valve interarea lower, anaplanate to catacline; notothyrium covered by low convex chilidium with shallow median sinus.

Pedicle valve interior. Teeth denticulate (Fig. 2, 15), with denticles extending posteriorly along walls of delthyrial cavity; teeth supported by thin weakly divergent dental plates extending anteriorly to about three-eighths valve length, and laterally bounding pentagonal muscle field. Latter is shallowly impressed, lacks containing ridges anteriorly, and extends to two-fifths valve length and one-fifth valve width; adductor and diductor scars not distinguished. Mantle canals indistinct. Valve periphery flattened laterally, narrowing anterolaterally and inflected towards brachial valve anteriorly.

Brachial valve interior. Twin erect lobes of cardinal process separated by minute ridge within narrow cleft, and supported on anchor-shaped notothyrial platform. Socket ridges short, widely divergent, recurved distally parallel to hingeline. Narrow weakly-developed median septum extends anteriorly from notothyrial platform, through indistinct muscle field, to between one-third and half valve length; other septa inconspicuous to absent. Mantle canals obscure. Periphery of valve thickened slightly, incised by closely-spaced grooves.

<i>Measurements</i>	L	W	L/W	T	Lmf	Wmf	Lsr	Wsr
Holotype SUP 62560 (Brachial valve)	13.3	20.0	0.67	2.1	—	—	1.2	3.9
Paratype SUP 62561 (Pedicle valve)	17.7	26.8	0.66	—	—	—	—	—
Paratype SUP 62562 (Brachial valve)	15.4+	27.0	—	—	—	—	2.3	7.8
Paratype SUP 62563 (Brachial valve)	13.2	22.0	0.60	3.0	—	—	—	—
Paratype SUP 62564 (Pedicle valve)	14.5	21.6	0.67	1.4	5.7	4.4	—	—
Paratype SUP 62565 (Brachial valve)	17.9	26.1	0.69	3.0	—	—	—	—
Paratype SUP 62566 (Pedicle valve)	10.6+	17.5+	—	—	—	—	—	—
Paratype SUP 62567 (Pedicle valve)	10.0+	21.2+	—	—	—	—	—	—

Remarks: The genus *Infurca* is at present represented only by its species *I. tessellata*.

Infurca tessellata gen. et sp. nov.

Fig. 2, 10-15

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Pedicle valve interior. Teeth denticulate (Fig. 2, 15), with denticles extending posteriorly along walls of delthyrial cavity; teeth supported by thin weakly divergent dental plates extending anteriorly to about three-eighths valve length, and laterally bounding pentagonal muscle field. Latter is shallowly impressed, lacks containing ridges anteriorly, and extends to two-fifths valve length and one-fifth valve width; adductor and diductor scars not distinguished. Mantle canals indistinct. Valve periphery flattened laterally, narrowing anterolaterally and inflected towards brachial valve anteriorly.

Brachial valve interior. Twin erect lobes of cardinal process separated by minute ridge within narrow cleft, and supported on anchor-shaped notothyrial platform. Socket ridges short, widely divergent, recurved distally parallel to hingeline. Narrow weakly-developed median septum extends anteriorly from notothyrial platform, through indistinct muscle field, to between one-third and half valve length; other septa inconspicuous to absent. Mantle canals obscure. Periphery of valve thickened slightly, incised by closely-spaced grooves.

<i>Measurements</i>	L	W	L/W	T	Lmf	Wmf	Lsr	Wsr
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Paratype SUP 62562 (Brachial valve)	15.4+	27.0	—	—	—	—	2.3	7.8
Paratype SUP 62563 (Brachial valve)	13.2	22.0	0.60	3.0	—	—	—	—
Paratype SUP 62564 (Pedicle valve)	14.5	21.6	0.67	1.4	5.7	4.4	—	—
Paratype SUP 62565 (Brachial valve)	17.9	26.1	0.69	3.0	—	—	—	—
Paratype SUP 62566 (Pedicle valve)	10.6+	17.5+	—	—	—	—	—	—
Paratype SUP 62567 (Pedicle valve)	10.0+	21.2+	—	—	—	—	—	—

Remarks: The genus *Infurca* is at present represented only by its species *I. tessellata*.

ACKNOWLEDGEMENTS

I am grateful to Associate Professor B. D. Webby for helpful criticism of the manuscript, and to Dr G. A. Cooper and an anonymous referee for comments on taxonomic problems. For their hospitality during fieldwork I thank the Buchan and Trotman families of Gunningbland. Mrs D. Garbler and Miss C. A. Johnson kindly typed the manuscript. This research was conducted during tenure of a Commonwealth Postgraduate Award at the Department of Geology and Geophysics, University of Sydney.

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